Childhood Overweight:
Family Environmental Factors

Leann L. Birch

Department of Human Development and Family Studies, The Pennsylvania State University, University Park, Pennsylvania, USA

Overweight parents are more likely to have children who become overweight. Family resemblances in weight status are well documented (1–4), reflecting the interplay of genes and family environmental factors. While children are growing up within the family, parents provide both genes and environment. Behavioral genetics research illustrates the important contribution of genetics to the obese phenotype, with genes or genetic similarity among family members explaining approximately 70% of the phenotypic variation in adiposity (5–7). Likewise, dramatic increases in the prevalence of overweight among children and adults within the past 20 years (8,9) attest to the critical role of the environment in the development and maintenance of overweight. Although we have learned a great deal about the genetics of obesity, we still have relatively little information about environmental variables that promote childhood overweight (10).

A research challenge for behavioral scientists is to delineate aspects of the family environment that mediate the development of family resemblances in adiposity and promote childhood overweight. Behavior genetics has characterized environmental effects as either shared or nonshared. Shared environments are those that are perfectly correlated across family members and influence the phenotype in the same way. Nonshared environments are those that are not highly correlated and are experienced differently by individuals within the same family. Nonshared environments result in different phenotypic outcomes across family members. Traditionally, family environments were assumed to be shared environments, affecting all children in the same way. Nonshared environments were assumed to exist outside the family. The assumption that family environments are shared environments, in combination with results from behavioral genetics research indicating minimal effects of the shared environment on phenotypic variation (2), have led to the erroneous conclusion that family environments do not matter (11). In fact, however, research has revealed that family environments and parenting practices do influence development but that it is the nonshared experiences among siblings that explain variability in phenotypic traits (12). Nonshared environments exist within families because parent–child interactions are bidirectional: parenting influences children and children influence
parenting (13). Because children influence parents, parenting practices differ across siblings, owing to sibling differences in age, sex, birth order, special abilities, temperament, and physical appearance (13,14). With respect to feeding environment, although siblings may eat from the same refrigerator and at the same table, feeding environments are nonshared because child feeding practices are a reaction to the child’s phenotypic characteristics at that point in development (15).

Domain-specific parenting (16) proposes that parenting is tailored to the child on the basis not only of phenotypic differences among children but also of parental concerns and perceptions of the child’s risk of developing a problem in that particular domain of development. Using obesity proneness in children to illustrate how domain-specific parenting works, Costanzo and Woody (16) reviewed research showing that parents modulate their child feeding practices according to the child’s current weight status, parental investment in weight and appearance, and parents’ perceptions of the child’s risk of overweight. When parents were highly invested in weight-related issues (possibly because they were overweight themselves) and perceived their child to be at risk of overweight, they were more likely to attempt to control and regulate their child’s food intake to alleviate proneness to obesity. However, they argue that these attempts to control the child’s intake limit the opportunities for the child to develop self-control, thereby promoting rather than alleviating the risk of overweight that the parents are trying to avoid. This model has been tested and supported by research from our laboratory, and illustrates one of a number of ways in which the family environment can mediate familial patterns of adiposity.

A model depicting familial factors hypothesized to promote familial patterns of adiposity and childhood overweight appears in Fig. 1. Direct genetic links between parental weight and child weight are acknowledged in the model (as shown by the direct arrow between parent and child weight status), but the focus is on displaying and discussing a set of mediating behavioral patterns within the family that promote

---

**FIG. 1.** Behavioral mediators of family resemblances in eating and weight status.
CHILDHOOD OVERWEIGHT: FAMILY ENVIRONMENTAL FACTORS 163

childhood overweight. The model illustrates how parents' weight status is linked to parents' own eating patterns and to their child feeding practices, which in turn influence children's eating behaviors and, in due course, the children's weight status. Specifically, parental eating styles, parents' food preferences, and the foods they consume and make available to their children all influence and are influenced by the parents' weight status (as shown by a double-headed arrow linking the two constructs). In turn, parent eating behaviors shape children's eating behaviors directly, as a result of social modeling and by the choice of foods available to children, and indirectly through their association with parents' child feeding practices. Child feeding practices—such as restricting children's access to food and pressuring children to eat certain foods—are largely driven by parents' own eating behaviors, children's current weight status, and parents' concern about future risk of overweight among their children (16). Finally, parent eating styles and child feeding practices shape children's eating behaviors, such as their food preferences and food selection patterns; in turn, children's eating patterns influence and are influenced by children's weight status.

Figure 1 is of limited scope, focusing exclusively on parent and child interactions and on the intake side of the energy balance equation. The focus on parenting does not imply that these are the only aspects of the family environment that may promote family resemblances in being overweight, but shows that efforts to delineate environmental variables and behavioral mediators can enhance our understanding of the modifiable factors involved in the development of childhood overweight, and point to areas where additional research is needed (10).

I will discuss aspects of this model in greater detail later. As a guide to the sections that follow, this chapter is structured around children's eating behaviors. Children's eating behaviors include food preferences, the ability to regulate energy intake on the basis of hunger and satiety cues, food selection, and meal initiation and termination. In addition, I will address the influence of parents' own eating patterns and of child feeding practices on these eating behaviors. I will also briefly discuss the larger social context in which parents feed their children (e.g., an environment that offers energy-dense, super-sized meals, places a high value on physical attractiveness and thinness in girls and women, and lacks time for food preparation). In the final section, I will review research assessing links between children's eating patterns and the risk of childhood overweight. Owing to a relative absence of research assessing behavioral mediators linking parent and child eating behaviors and weight status, most of the research relating to this model is from my own laboratory.

CHILDREN'S FOOD PREFERENCES: PARENTAL INFLUENCE

Children learn an enormous amount about food and eating during the first years of life, and this learning occurs in the family context. Through early experience with food and eating, children's genetic predispositions become patterns of food preferences and food intake, and these influence their weight status. Genetic predispositions include a preference for sweet and salty tastes, rejection of sour and bitter tastes, a tendency to reject novel foods, and the ability to learn to like and dislike foods
based on the social contexts and physiologic consequences of eating (17). Young children depend on their parents to provide food, and the child’s food environment is constrained and shaped by the parents’ own food preferences and food selections, which in turn are determined by the larger cultural and economic context: the cost, convenience, taste, and availability of food. Although parents shape children’s eating environments, determining what foods are offered and the timing and size of meals and snacks, young children’s food preferences do not closely resemble their parents’ food preferences (18). However, food preferences of adult children do resemble those of their parents (18,19). Perusse and Bouchard (20) reported only modest genetic effects on food preferences and found that cultural and environmental factors accounted for about 80% of the substantial within and between family variation in food preferences.

Early experience with food is especially crucial to children’s developing patterns of food preference and intake because children are neophobic, initially rejecting new foods despite their need for increased dietary variety. When the child begins the transition from the exclusive milk diet during weaning, all foods are new and acceptance of these foods is critical in establishing dietary patterns that will support growth and health. Fortunately, if children have repeated opportunities to sample new foods, then some foods will be accepted. When preschool children had repeated experience with a new food, it became more familiar and their preference for the food tended to increase (21,22). Therefore children’s food preferences and food intake patterns may be largely shaped by the foods the parents choose to make available to their children, and their persistence in presenting a food that is initially rejected. Our genetically determined preference for sweet and salty foods guarantees that many such foods will be readily accepted. For other foods—including meats, grains, and vegetables—relatively extensive experience is necessary for food acceptance.

Research with animal models has revealed that “learned safety” may be responsible for the reduction of neophobia through repeated consumption of new foods (23): When ingestion of a new food is not followed by illness, we learn that the food does not cause illness, and neophobia is reduced. If illness does follow, a conditioned aversion to that food may develop. Food preferences can also be learned, based on the positive postingestive effects. Rats and humans can learn to prefer flavors associated with energy-dense over energy-dilute foods or drinks (24,25). Children readily learn to prefer flavors previously associated with energy-dense over energy-dilute paired flavors (26,27). Although learned preferences for energy-dense foods may have been adaptive in times of food scarcity, in today’s obesity-promoting food environment, where energy-dense foods are inexpensive and readily available in large portions, such preferences can promote overconsumption and overweight (28).

CHILDREN’S EATING: A SOCIAL ACTIVITY

Children’s early eating experiences typically occur in a social context, first involving the mother–infant dyad, then, increasingly, other eaters who can serve as models, and also adults who use child feeding practices to control children’s eating. Much of our
CHILDREN'S RESPONSIVENESS TO HUNGER AND SATIETY CUES: EFFECTS OF EXPERIENCE AND LEARNING

Infants are able to regulate their energy intake on the basis of their physiologic needs, reflecting a responsiveness to internal hunger and satiety cues. Infants older than about 6 weeks adjusted their formula intake in response to differences in the energy density of the formula, consuming greater volumes of a formula with a low energy density than of one with a high energy density, so that the total energy intake remained similar (33). Preschool children can also adjust the amount of food they consume in response to changes in the energy density of their food, maintaining a relatively constant energy intake across changes in energy density (34,35). In addition, over 24-hour periods children maintained relatively consistent total daily energy intakes, and this was attributable to meal-to-meal adjustments in energy intake (36). When olestra was substituted for dietary fat for about 10% of the total daily energy intake, thus diluting the energy density of the diet, children increased their self-selected intake to maintain total 24-hour energy intake at levels similar to the control condition (37). The ability to regulate energy intake closely, based on physiologic need, is an adaptive behavior preventing overweight. With increasing age, we see increasing individual differences in children's responsiveness to energy density as a factor controlling food intake.

The substantial individual differences among children in their ability to regulate their energy intake led us to investigate whether feeding practices could foster differences in regulatory behavior. Parents' feeding practices provide guidance for their children about which cues they should be responsive to in controlling their food intake. A child who reports she is full but is told to clean her plate may learn to ignore her internal feedback signaling feelings of fullness, and focus instead on finishing the portion served to her. When a child says, "I'm hungry" and is told, "Not now, wait until mealtime," the child may learn that it is the presence of food, not hunger, that should initiate eating. Finally, if parents chronically restrict children's access to
palatable snacks, children may learn to eat in the presence of food, whether or not they are hungry. Research from our laboratory supports these ideas. In one particular study, adults encouraged children to focus on feelings of hunger and fullness ("internal" condition), or in the contrasting "external" condition children were pressured to "clean up the plate" (38). Over a series of subsequent meals, children who were focused on hunger and satiety cues adjusted their intake to compensate for manipulations in the energy density of the meal so that they maintained a consistent total energy intake. However, children in the external context did adjust their intake in response to changes in energy density, showing that their responsiveness to energy density was easily overridden by feeding practices that emphasized external cues, such as pressure to finish the portion. We have also found that heavier girls were subjected to greater parental control, thus illustrating nonshared environmental influences, and they showed less capacity to adjust their intake in response to differences in energy density (39); no consistent relation was noted for boys. Thus, although parents need to set limits, there appears to be an inherent tension between socializing children into eating at mealtimes while supporting their capacity for self-regulation.

FAMILY RESEMBLANCES IN FOOD INTAKE PATTERNS

Children’s food intake patterns are influenced by their food preferences and sensitivity to hunger and satiety cues. The foods that parents make available to children, the extent to which parents restrict their children’s access to food, and their own eating behaviors all contribute to the context in which children learn about food and eating. Many years ago, Davis demonstrated that when young children were offered a variety of healthful foods in the absence of adult attempts to control or coerce their eating, the children selected diets that supported adequate growth and health (40,41). She pointed out that the secret to the children’s success was in the array of healthy, unseasoned, unprocessed foods offered to them. This context is radically different from that provided today for a child in the United States or other Westernized cultures, and the effects of the contemporary food environment on children’s dietary intake and weight status must be systematically examined. Current data reveal that today’s children—living in an obesity-promoting food environment that provides readily available, cheap, energy-dense, palatable foods in large portions (42)—are consuming diets that are too high in sugar and fat and that contain too few servings of fruits, vegetables, grains, and dairy products (43). Given this larger cultural and economic context, what are parents to do to foster healthy eating patterns in their children?

One straightforward approach to teaching children moderation in their intake of snack foods high in sugar, fat, and energy density involves restricting children’s access to palatable snacks or "junk" food. However, research suggests that potentially problematic eating styles in children may be fostered by parents’ well-intended attempts to help children control their food intake. Using both experimental and naturalistic research designs, we have found that restricting preschool children’s access to certain foods promoted children’s attention to, and intake of, the restricted foods
CHILDHOOD OVERWEIGHT: FAMILY ENVIRONMENTAL FACTORS 167

when they became available, even if they were not hungry (44,45). There is also limited evidence that these practices shape individual differences in styles of intake control, including dietary restraint and eating in the absence of hunger, and aspects of dietary disinhibition. Five-year-old girls’ perceptions of parental use of pressure and restriction in child feeding predicted the development of dietary restraint and disinhibition among girls (46). Pressure to eat can be interpreted as “coaching” children to eat in response to the presence of food, even in the absence of hunger. This may, in turn, lead girls toward disinhibited eating styles, and finally toward attempting to control their intake cognitively rather than relying on hunger and satiety cues. As in other domains of children’s development, parental imposition of high levels of external control may promote problems in self-regulation (47). These parenting practices can promote problems of self-regulation in the feeding domain, fostering children’s intake of “forbidden” foods, avoidance of “healthy” foods, and development of styles of intake control that can place children at risk of chronic dieting, dietary restraint and disinhibition, binge eating, problems of energy balance, and overweight.

PARENTS AS MODELS FOR CHILDREN’S EATING

There is some evidence that parents are also models for children’s eating. One change in children’s diets during the last 30 years is a dramatic increase in soft drink consumption, and increased soft drink consumption is linked to greater increases in weight status (48). Harnack et al. (49) reported that children who were high consumers of soft drinks also consumed significantly more total energy, more sugars, and less milk. We have asked whether parental patterns of soda intake may influence children’s soda intake. Mothers’ and daughters’ milk and soft drink intake are negatively correlated, and mothers’ patterns of beverage intake influence their daughters’ intakes; mothers’ milk and soft drink consumption predicted daughters’ intake of these beverages (50). Mother–daughter similarities in intake have also been reported for fruits and vegetables (51) and for diet composition. When Lee et al. (52) compared the diets of girls meeting the American Academy of Pediatrics guidelines for dietary fat (more than 20% but less than 30% of energy from fat) with diets of children consuming diets containing more than 30% of energy from fat, results showed that girls’ diets reflected their mothers’ diets. Mothers of girls consuming diets with more than 30% of energy from fat also had diets higher in fat, lower in fiber, and lower in vitamin A and C, riboflavin, folate, and calcium than mothers of girls consuming diets with less than 30% of energy from fat. These findings collectively highlight the importance of parents’ food selection and intake patterns in shaping children’s dietary intake and suggest that parents need to lead by example when encouraging children to select healthy diets. As depicted in Fig. 1, parents’ eating habits and their use of child feeding practices such as restriction and pressure are intricately linked to each other and to the parents’ weight status, thereby illustrating that each of these factors is likely to be an intermediary linking parent and child weight status. Using structural equation modeling, we tested the influence of maternal characteristics and practices on daughters’ eating and weight (53) and found that
the mother’s own dietary restraint (or the cognitive and behavioral restriction of food intake) predicted her use of restrictive feeding practices with her daughter, and restrictive feeding predicted daughters’ weight status independently of maternal weight. Similarly, we found that mothers’ disinhibited eating, or overeating in the presence of palatable foods, mediated resemblances in weight status in mothers and their preschool-aged daughters (54). When girls were given unrestricted access to palatable snack foods, including chocolate chip cookies and potato chips, following a meal eaten to satiety, girls’ intake of these foods was associated with their mothers’ reports of disinhibited eating and with their mothers’ weight status—mothers who were more overweight were more likely to report disinhibited eating, which in turn was associated with greater free access intake among girls, independent of girls’ weight status. Daughters’ free access intake of palatable snack foods and mothers’ disinhibition accounted for 49% of the variance in daughters’ weight status. Family resemblances between mothers’ and daughters’ eating and weight status reflect genetic factors, modeling effects, food availability, and child feeding strategies. Research is needed to delineate the relative contributions of genetics, modeling, and feeding practices to the emergence of family resemblances in eating behaviors that may mediate family resemblances in adiposity.

CHILD FEEDING IN AN OBESITY-PROMOTING ENVIRONMENT

Child-feeding practices, including restriction and pressure, that promote children’s overeating in response to the availability of palatable foods may be especially problematic in today’s “obesigenic” food environment (42). For example, American portion sizes have become very large (42), especially relative to children’s energy needs, and food is inexpensive, energy-dense, and readily available. Fast food stores, convenience marts, and vending machines have expanded the availability of energy-dense, inexpensive, palatable foods. Lifestyle changes include the expansion of eating beyond mealtimes to a wide variety of work and leisure settings, and there is evidence that snacking is increasingly frequent. Popkin and colleagues (55) have reported that during the period when the prevalence of childhood overweight has doubled for children and adolescents (56), the frequency of snacking by children and adolescents also increased significantly. In addition, snacks tended to be more energy-dense and to be higher in fat than meals during that period, contributing to the increased energy and fat intakes.

Portion sizes have increased in recent years, and are often very large, especially relative to children’s energy needs. Large portions are the norm, particularly for meals purchased away from home, and inexpensive “super-sized” or “value-sized” foods are common. When adults are served larger portions, they eat more (57,58). What impact do these large portions have on children’s intake? Recently, we investigated the effects of portion size on young children’s intake: The younger group’s mean age was 3.5 years, whereas the older group’s was 5. Children consumed a series of lunches differing in the portion size of the entrée (macaroni and cheese). Although the 3-year-olds’ intakes were not related to the portion sizes they were
served, the 5-year-olds increased their intake significantly as portion size increased—a pattern similar to that noted for adults. This pattern of findings reflects the child’s increasing awareness and emphasis on external cues as controls of food intake from 3 to 5 years. Additional research is needed to determine how children learn about appropriate portion sizes, and whether child-feeding practices can shape individual differences in children’s responsiveness to portion size.

CHILDREN’S EATING: LINKS TO OVERWEIGHT?

In this chapter, I have focused on familial factors, outlined in Fig. 1, that shape children’s eating patterns, and on how these factors are linked to parents’ weight status. A discussion of behavioral mediators of familial similarity in weight status is not complete, however, without considering links between the children’s eating patterns—including food preferences, energy regulation, and food intake—and their body weight. Heavier children report a greater preference for fat (59), and such children also tend to regulate their energy intakes less precisely (39). Links between children’s dietary intake and childhood overweight have been investigated, with a focus on whether diet composition, differences in the percentage of energy from fat, or patterns of food group intake can predict differences in body weight. Although most research has revealed higher energy intakes among obese than among normal-weight children, these findings do not shed light on the etiology of overweight, bearing in mind that higher energy intakes are needed to maintain energy balance in overweight children, given their greater lean body mass and fat mass (60). Relations between children’s weight status and macronutrient composition of the diet have also been reported, with overweight children consuming diets that provide a greater proportion of energy from fat (59,61,62). Among adults, there is extensive evidence that the percentage of energy from fat is linked to overweight (63,64). (Ref. 64 is a rebuttal of this point.) As a result of the cross-sectional nature of these studies, it is difficult to determine whether children are overweight because they have a preference for fat, have difficulties regulating intake, and consume diets high in fat, or whether the reverse is true. It is likely that both are true; that is, children’s eating styles contribute to their becoming overweight and their overweight status is maintained or exacerbated as a result of their eating styles.

Longitudinal data are the key to determining how dietary intake patterns may contribute to the development of childhood overweight. Several recent longitudinal studies (52,65–68) show that higher levels of dietary fat intake are associated with greater increases in weight among children. Eck et al. (65) followed children who differed in risk for overweight based on their parents’ weight status and noted that the high risk group gained more weight over a 1 year period and consumed a greater proportion of their energy from fat. Klesges et al. (66) examined weight change among 146 children over a 3-year period, and noted that the percentage of energy from fat predicted weight change over that period. Lee et al. (52) categorized children on the basis of whether they met or exceeded the American Academy of Pediatrics guidelines for dietary fat intake (more than 20% but less than 30% of energy from fat, or more than
30% of energy from fat), and found that children consuming diets with more than 30% of energy from fat showed significantly greater gains in both body mass index and in skinfold thickness from ages 5 to 7 years. As reported previously, mothers of girls consuming higher-fat diets also consumed diets that were higher in fat (52). Taken together, these findings implicate the percentage of energy from fat in the development of childhood overweight and provide additional evidence for environmental mediation of familial patterns of overweight through parent–child similarities in dietary fat intake.

CONCLUSIONS

Although research has assessed genetic links between parent and child weight status, relatively little research has assessed the extent to which parents (particularly parents who are overweight) select and provide environments that promote overweight among their children. Parents provide food environments for their children’s early experiences with food and eating. These family eating environments include the foods parents make available to children, parents’ own eating behaviors, and child-feeding practices. There is evidence that all these facets of the family eating environment shape the development of eating behaviors in children: Behavioral mediators of familial patterns of overweight include parents’ own eating behaviors and their parenting practices, which influence the development of children’s eating behaviors and mediate familial patterns of overweight. In particular, parents who are overweight, have problems controlling their own food intake, or are concerned about their child’s risk for overweight may adopt controlling child-feeding practices in attempts to prevent overweight in their children. Unfortunately, evidence suggests that these parental control attempts may interact with genetic predispositions to promote the development of problematic eating styles and childhood overweight. Although we have argued that behavioral mediators of family resemblances in weight status—such as disinhibited or binge eating and parenting practices—are shaped largely by environmental factors, individual differences in these behaviors also have genetic bases (69–72).

A primary public health goal involves the development of family-based prevention programs for childhood overweight. Taken together, the findings I have reviewed here suggest that effective prevention programs must focus first on providing anticipatory guidance to help parents foster patterns of preference and food selection in their children that are more consistent with healthy diets; and second, on promoting their children’s ability to self-regulate their intakes. Guidance for parents should include information on how children develop patterns of food intake in the family context, and practical advice on how to foster children’s preferences for healthy foods and promote their acceptance of new foods. Parents need to understand the costs of coercive feeding practices and be given alternates to the use of restriction and pressuring children to eat. Providing parents with easy-to-use information regarding appropriate portion sizes for children is also essential, as are suggestions on the appropriate timing and frequency of meals and snacks. Especially during early and middle
CHILDHOOD OVERWEIGHT: FAMILY ENVIRONMENTAL FACTORS

childhood, the family environment is the key to the development of food preferences, patterns of food intake, and eating styles, as well as activity preferences and patterns that shape children's developing weight status.

To design effective prevention programs, more complete knowledge is needed on behavioral intermediaries that foster overweight, including the family factors that shape activity patterns, meals taken away from home, the impact of stress on family members' eating styles, food intake, activity patterns, and weight gain. The research I have presented in this chapter illustrates how ideas regarding the effects of environmental factors and behavioral mediators on childhood overweight can be investigated. Such research requires the development of reliable and valid measures of environmental variables and behaviors. Because childhood overweight is a multifactorial problem, additional research is needed to develop and test theoretical models describing how a wide range of environmental factors and behavioral intermediaries can work in concert with genetic predisposition to promote the development of childhood overweight. The critical test of these theoretical models will be the success of preventive interventions based on such models.

REFERENCES

172 CHILDHOOD OVERWEIGHT: FAMILY ENVIRONMENTAL FACTORS

CHILDHOOD OVERWEIGHT: FAMILY ENVIRONMENTAL FACTORS


DISCUSSION

Dr. Urazy: I’m surprised you did not put more emphasis on advertising to children. How can we counteract the effects of advertising?

Dr. Birch: It’s obviously extremely important, though it’s difficult to measure. Our focus has been more on whether we can help parents with parenting skills than on taking on the advertising industry or the food industry. But clearly it’s enormously important and we are not going to make progress without that as well. I appreciate your comment.
Dr. Endres: In relation to TV advertising and the blackmailling of mothers by their children at the supermarket, an investigation in Germany (Diehl JM, Giessen, Germany, personal communication, 1998) has shown that 5- to 8-year-old children already put pressure on their mother to buy certain things they have seen advertised in the media. What is your experience in the United States?

Dr. Birch: Various published studies have confirmed that this is happening in the United States (1). This is a huge issue, and one we have to find a way to address. Just teaching mothers to deal with it in the supermarket is probably not enough.

Dr. Bellizzi: One of your later slides referred to the importance of experiences with food and eating. From my personal experience, food, eating, and cooking are all important in helping a child to understand about food in a way that is fun. What is the influence of nurseries on children's eating habits? Nowadays, young children spend a great deal of time at nurseries and may take most of their meals there. How does that affect the exposure they are getting at home?

Dr. Birch: We know very little about that. In the United States a large proportion of young children are in day care centers for 30 or more hours a week and that's got to be very important in this context, especially as their caregivers often come from very different socioeconomic and ethnic groups. We find the parents' influence remains strong even in cases where their children are in childcare for 30 to 40 hours a week, but it is inevitable that the caregivers will also exert powerful effects. Parents whose children are in childcare all day long may only see them eating at breakfast and in the evening, and this can be a source of anxiety, especially when their children may not be particularly interested in eating because they have been eating during the day.

Dr. Bellizzi: I also have a question about your chips experiment, where you showed that children who were 3.5 years old regulated their intake regardless of the portion size, whereas older children ate according to the portion size. Is that because we lose the ability to distinguish how much food we eat, or is it because of an environmental impact?

Dr. Birch: What happens with most people is that there is an overlay of all kinds of cultural factors, and the eating becomes increasingly culturally determined as you get older, so that things like the time of day, the presence of foods, whether or not other people are eating, and expectations of various kinds come into play. What we are seeing with these very young children is the transition period from a food depletion drive to a drive that is increasingly controlled by a variety of external factors. This is really a most important time for preventing the development of overweight.

Dr. Endres: I have a question about salt foods for young children. There is an ongoing discussion of how much sodium young children may eat. In processed foods, at least in Europe, the upper limit is normally 200 mg/100 g. It is known that in homemade foods the sodium content is often much higher, say 500 to 700 mg/100 g. What is your experience in this respect?

Dr. Birch: I think immediately of Beauchamp's work, where he showed that very young toddlers and preschool children have preferences for high levels of salt in, for example, soup—much higher than they probably ever experienced in daily eating (2). This parallels work showing that people on low-salt diets increase their salt intakes quite dramatically as soon as they have the opportunity to consume higher-sodium diets. I don't think that is a good thing—I'm just saying that this is what tends to happen given our predispositions.

Dr. Endres: I think that if the upper level is set too low there is a high risk that mothers will add extra salt. I believe that the level should be somewhat higher than at present, say, 300 mg/100 g.

Dr. Anantharaman: I have a question concerning variety. Is there anything to suggest that a breast-fed child is more willing to accept variety in the weaning diet because of exposure to different flavors in breast milk?
Dr. Birch: There is not much in the literature yet, although there will soon be more. For example, Mennella has done a whole series of elegant studies looking at the effects of including different substances in the maternal diet—garlic, vanilla, alcohol, and so on—and studying their presence in breast milk and the acceptance of those foods by infants and toddlers (3). We ourselves did some work years ago which was published in Pediatrics (4), looking at breast-fed versus formula-fed infants and their acceptance of initial solids. We found that breast-fed infants were more ready to accept solids, and this is consistent with the animal work showing that the flavors from the maternal milk lead to preferences for the maternal diet, and that early variety tends to lead to the later, more ready acceptance of new diets (5).

Dr. Anantharaman: So in that context, would you expect that in the preparation of weaning foods, something that might facilitate weaning could be the addition of flavors that a breast-fed child might have been exposed to, a weaning food with a garlicky flavor or whatever?

Dr. Birch: This is a really interesting area, and it’s amazing to me that there hasn’t been more work done on it. There has been some discussion in the industry about adding flavors to formula or to puréed transition foods, but to my knowledge that hasn’t got very far yet. We know a lot more about rat pups than we do about humans, and in the rat the transition to solids is clearly facilitated by the cues the mothers’ diets give to the pups (6).

Dr. Jiang: I was very interested in your presentation. Can you suggest a good way to prevent a child from overeating?

Dr. Birch: If I could answer that I’d be rich and famous! One thing is to assist children to prefer food that are not so energy-dense. This requires giving them lots of opportunities to eat complex carbohydrates, fruits, vegetables, and so on. Another thing that is very important is parental education about appropriate portion sizes. This may be different in China, but in the United States, parents often have very inflated ideas of how much young children need to eat to sustain growth. For example, they may expect 2-year-olds to eat portions that are two or three times as big as the child needs. We need to help children to have opportunities to self-regulate and self-select rather than thinking we can impose all the controls from without, because that doesn’t work!

Dr. Bar-Or: It seems to me that your data relate mostly to children from the general population who are not necessarily obese. Are there any data on learning patterns in toddlers or preschool children who do become obese, and if so do they differ from children who are not yet obese?

Dr. Birch: There is some indirect evidence that relates to your point. For example, Agras and his colleagues (7) have shown that differences occurring very early on in terms of sucking performance are related to the development of obesity—that is, the infants who are the most lively feeders at the breast or the bottle tend to be the ones who become obese later on. We found in our own work that there is a relation between children’s responsiveness to energy density, both in the short term and over 24-hour periods, and their weight status. As to whether or not there are differences in the learning process that might be related to weight status, I don’t know whether anybody has done that work. It needs to be done.

Dr. Chen: In China, we are increasingly providing education in nutrition—dietary guidelines, what foods are nutritious, and so on. But we don’t teach the children much about food and eating, or about how to make good choices about food, and about which are energy-dense foods. These things are not well taught to children in China.

Dr. Birch: For years, we have been telling our children “eat this; it is good for you,” or “don’t eat that; it’s not good for you,” but we know that this is just not effective. For both adults and children, preferences tend to drive intake within the constraints of what is available. So we need to learn to help children to like what it is that we think they should eat.
REFERENCES